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The concept of hip resurfacing is not new. In the 1970s, Calandruccio had experience with total hip articular replacement by concentric shells (THARIES) that consisted of an all-polyethylene acetabular component and a metal femoral cap. Both components were cemented, but because the femoral component was as large as a normal femoral head, acetabular bone had to be sacrificed. At the same time, the all-polyethylene cup design was very thin and failures were primarily on the acetabular side of the hip. The THARIES was abandoned by the mid-1980s in favor of total hip replacement with smaller femoral heads and thicker acetabular components. Despite these early failures with hip resurfacing, the appeal of a hip more appropriate for younger, more active patients persisted. Also appealing was the concept of bone preservation in the proximal femur that would reconstruct a painful joint and at the same time preserve a patient’s own natural anatomy and biomechanics. Leg length and offset are not altered with resurfacing, and the patient’s own proximal femoral bone is preserved.

Since the problems with early resurfacings were thin polyethylene acetabular components and loss of acetabular bone stock, these problems were eliminated by solid metal ingrowth type acetabular components. To achieve acceptably low rates of wear, attention to maintaining high levels of diamond-like molecules of carbide in the metal was necessary. This requires an exact manufacturing technique that calls for the beads on the back of the acetabular component to be cast into the metal rather than sintered in place as is the usual technique of manufacturing. In addition, wear is lessened by manufacturing tolerances within 2 microns and substantial implant stiffness to prevent deformation of the components during implantation.

Since the reintroduction of hip resurfacing in the United States in 2006, problems with local reactions to the accumulation of chrome and cobalt metal wear debris in metal-on-metal hips have been recognized. It is important, however, to realize that the greatest risk of metal-on-metal hips is in total hips rather than in hip resurfacing. While the survival of metal-on-metal hip resurfacing is 98% at 15 years in men, the survival of metal-on-metal total hip arthroplasties has been poorer. The junction of the trunion of a femoral stem to the inner portion of the large femoral head (trunion taper junction) is the reason for the difference. Metal-on-metal hip resurfacings also have had some reported complications from metal ion and particulate debris, and the incidence of wear is greater in some implants, while others have had a lower incidence of metal ion elevation and failure. The incidence of serum metal ion elevation and local complications, such as pseudotumor and chronic hip pain is greatest in (1) women, (2) patients with femoral head size smaller than 50 mm, and (3) hips in which the abduction angle of the acetabulum is greater than 50 degrees.

In 2013, Liu and Gross introduced the idea of an acetabular component “safe zone.” Their observation was that the smaller the femoral head component, the more sensitive to wear the acetabular component will be with greater abduction inclination. For a 52-mm head component, the ideal acetabular inclination would be abduction of 48 to 57 degrees, while for a 48-mm head the acetabulum should have less abduction at 43 to 52 degrees (Fig. 4-1). Acetabular component position with the “contact patch to rim distance” farther away from the edge of the acetabular component is critical to success of hip resurfacing.

### PATIENT SELECTION

We limit hip resurfacing mainly to active men younger than the age of 60 years with osteoarthritis or posttraumatic arthritis. Nearly normal proximal femoral anatomy is needed to provide a satisfactory bony substrate for implant fixation. Hip resurfacing may be more beneficial for male manual laborers who are required to squat, which generally is not allowed after conventional total hip replacement. Also, the well-informed patient whose recreational activities, such as running, squatting, etc., make a conventional hip replacement an unacceptable choice may be a good candidate for a hip resurfacing procedure.

Patients with osteonecrosis or large femoral head cysts may or may not be candidates for a resurfacing based on how much intact viable femoral head remains after contouring the head for the resurfacing component. As a rule, three fourths of the femoral head should be intact after contouring the head. There is a greater incidence of failure secondary to femoral component loosening in patients with osteonecrosis.

Because femoral neck fracture has been reported in 1% of the Australian Registry, bone quality should be considered before doing a hip resurfacing; patients with osteoporosis should not be considered candidates for this type of procedure.
The results of hip resurfacing at our institution remain excellent (0.5% revision rate in over 200 hips). Femoral aseptic loosening was noted in one patient who required a revision. The published results also remain excellent, especially in men. McMinn et al. reported 98% average 15-year survival rate in men and 91% in women. A Canadian series reported similar results with shorter follow-up. Since the results of hip resurfacing in women have not been as satisfactory, we recommend total hip arthroplasty for women, small men, and patients who are not active enough to justify the added risks of the procedure, which include serum metal ion elevation, pseudotumor, and chronic hip pain.

The issue of metal hypersensitivity and the development of local tissue reactions have discouraged many from pursuing hip resurfacing. To date, we have not seen these reactions in the resurfaced hips in our practice, but we remain watchful for its development. Also associated with early failure is acetalubar dysplasia. This may well be because the acetalubar component is fixed in a more “open” or abducted position in these patients. That position of the acetabulum is known to increase wear on the edge of the acetabular component against the metal head of the femoral component. For this reason, patients with acetalubar deficiencies or dysplasia should have resurfacing with a specific “dysplasia” cup placed against the metal head of the femoral component. For this reason, patients with acetalubar deficiencies or dysplasia should have resurfacing with a specific “dysplasia” cup placed against the metal head of the femoral component. For this reason, patients with acetalubar deficiencies or dysplasia should have resurfacing with a specific “dysplasia” cup placed against the metal head of the femoral component. For this reason, patients with acetalubar deficiencies or dysplasia should have resurfacing with a specific “dysplasia” cup placed against the metal head of the femoral component.

The first step in templating is to measure the size of the femoral component. A template is laid over a radiograph of the proximal femur. The width of the opening of the femoral component should be wider than the femoral neck by 2 to 4 mm total. If not, the next larger template should be used. Then, the center post of the implant is aligned over the center of the femoral neck on radiograph. The line from the top of the greater trochanter to where the line on the template intersects the lateral cortex is measured and documented (Fig. 4-3A). This distance will be used when measuring the valgus angle of the implant intraoperatively (Fig. 4-3B).

**POSTOPERATIVE MANAGEMENT**

Patients who have had their hips resurfaced rather than replaced have a much more rapid recovery to a much more normal level of activity than patients with traditional posterior hip replacements in our practice. Because the risk of dislocation is negligible (0.3% in the Australian Registry), no abduction pillow is used, and patients do not have to follow strict hip range of motion precautions. The patient is mobilized to low impact activity very rapidly. Most patients return to a higher level of activity by 2 to 3 weeks.

For the first 6 months after surgery, the patient is encouraged to participate in low-impact activities such as walking, swimming, and cycling. This gives the acetabular bone a good chance for fully stable ingrowth and allows the femoral neck to remodel after the trauma of the surgery. After this, patients are released to full activity, including running, soccer, and skiing. They should be informed of course that these activities do carry increased risk of fracture (acute or stress fractures); the risk of injury should be balanced by the reward of activity.

**OUTCOMES**

The results of hip resurfacing at our institution remain excellent (0.5% revision rate in over 200 hips). Femoral aseptic loosening was noted in one patient who required a revision. The published results also remain excellent, especially in men. McMinn et al. reported 98% average 15-year survival rate in men and 91% in women. A Canadian series reported similar results with shorter follow-up. Since the results of hip resurfacing in women have not been as satisfactory, we recommend total hip arthroplasty for women, small men, and patients who are not active enough to justify the added risks of the procedure, which include serum metal ion elevation, pseudotumor, and chronic hip pain.

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Other complications of deep venous thrombosis, pulmonary embolus, heterotopic bone formation, and intraoperative nerve or vessel injuries appear to be comparable to those of total hip arthroplasty.
FIGURE 4-2  A and B, Preoperative views of femoral head and neck before templating.

FIGURE 4-3  Templating of femoral component. Measurement will be used intraoperatively to measure valgus angle.

HIP RESURFACING TECHNIQUE—BIRMINGHAM HIP REPLACEMENT

Numerous hip resurfacing implants are commercially available, but our current experience has been with the Birmingham Hip Replacement (BHR) system (Smith and Nephew, Memphis, Tennessee), which is described below. Many of the same principles apply among all hip resurfacing procedures; however, for other hip replacement systems the reader is referred to the respective technique manuals.

TECHNIQUE 4-1

POSITIONING

- Position the patient in the lateral position with the affected hip up. Stabilize the pelvis with a pelvic clamp or pegboard, with the pelvis oriented straight up and down. If the pelvis is leaning forward, the acetabular component may be placed in retroversion; and if it is leaning backward, the acetabular component may be placed in excessive anteversion.

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4-4

APPROACH AND EXPOSURE

- To resurface the hip, extensive exposure is necessary to allow the acetabulum to be visible and later on in the procedure to keep the femoral head visible over its entire surface. Therefore, steps must be taken to achieve exposure not commonly used in total hip replacement surgery. Obviously, the femoral head is removed during a total hip replacement, which greatly aids in exposure.

- Make a curved skin incision over the greater trochanter, angling the proximal portion posteriorly, pointing toward the posterior superior iliac spine (Fig. 4-4A). Carry the incision over the center of the greater trochanter and then distally over the shaft of the femur to end over the attachment of the gluteus maximus on the linea aspera.

- Divide the subcutaneous tissue in a single plane over the fascia of the gluteus maximus proximally and the fascia of the iliotibial band distally. Make a longitudinal incision over the middle to posterior third of the fascia over the greater trochanter and extend it distally over the femoral shaft. Extend the proximal end of the incision through the thin fascia over the gluteus maximus in the same direction as the skin incision. Bluntly split the fibers of the gluteus maximus muscle, taking care to find and cauterize any bleeding.

- Release the tendinous attachment of the gluteus maximus from the linea aspera to maximally internally rotate the femur to provide satisfactory exposure of the proximal femur and femoral head. If the gluteus maximus is not released, the sciatic nerve may be at risk of compression at the time of preparation of the femoral head. Place a hemostat under the gluteus maximus tendon as the tendon is divided to avoid injuring branches of the medial femoral circumflex artery and the first perforating artery. Leave a centimeter of tendon attached to the linea aspera and femoral shaft for later repair.

- Widely spread the fascial plane just divided using a Charnley or self-retaining retractor. The posterior greater trochanter and gluteus medius should be easily seen. Remove the trochanteric bursa.

- Retract the gluteus medius muscle and tendon anteriorly. A hooked instrument such as a Hibbs retractor is useful. Under the gluteus medius is the piriformis, which is exposed. Tag the piriformis tendon with suture, and then release it from the femur. Under and anterior to the piriformis tendon are the muscle fibers of the gluteus minimus. With an elevator, raise the gluteus minimus off the capsule of the hip completely. The entire capsule of the hip should be exposed superiorly. Use of a narrow cobra retractor is helpful to see this area when it is placed under the gluteus minimus and medius.

- Expose the plane distally between the capsule and the short external rotator muscles. Release the short external rotator muscles off the femur including the quadratus femoris distally. Coagulate the vessels in this area.

- The capsule of the hip is now completely exposed posteriorly, superiorly, and inferiorly. The lesser trochanter also is visible. With the hip in internal rotation, make an incision in the capsule circumferentially, leaving at least a centimeter of capsule still attached to the femoral neck. This centimeter of capsule is later used to repair the capsule back as well as to provide protection to the intraosseous vessels needed to maintain vascularity of the femoral neck.

- Make two radial incisions in the posterior capsule to create a posterior capsular flap. This is helpful for retraction and later repair (Fig. 4-4B).

- Dislocate the femoral head and perform a complete anterior capsulotomy with sharp scissors. The inferior portion of the capsule is seen by extending and internally rotating the femur. The psoas tendon is exposed at the lesser trochanter, and the capsule is isolated just in front of the psoas tendon. While maintaining the scissors just posterior to the psoas tendon, incise the capsule from inferior to superior (Fig. 4-4C). Maintain the femur in internal rotation and apply anterior traction with a bone hook on the lesser trochanter.

- Perform the proximal end of the capsulotomy by flexing the femur 90 degrees and maintaining a narrow cobra retractor under the gluteus muscles. Incise the capsule with sharp scissors while internally rotating the femur to beyond 100 degrees. If a complete capsulotomy is not performed, exposure of the femur is compromised.

- Measure the femoral neck from superior to inferior, its longest dimension (Fig. 4-4D). The measurement tool should loosely fit over the femoral neck to avoid undersizing the femoral component, which could cause notching of the femoral neck. Femoral neck notches may weaken the neck and predispose it to early postoperative fracture. If there is any doubt, choose the next larger size of the femoral head component.

- Once the size of the femoral component is known, the acetabular component size also is known because the acetabular component is matched with components either 6 or 8 mm larger than the femoral component. Therefore, if the femoral head measures 52 mm, the acetabular component will need to be either 58 or 60 mm. That means (in this case) the acetabulum will need to be reamed to 57 or 59 mm, respectively.

- The key to exposure of the acetabulum is to dislocate the femoral head out of the way anteriorly and superiorly. Create an anterosuperior pouch large enough for the femoral head under the gluteus muscles and above the ilium. This is done by sharply dissecting the soft tissues off the bone of the ilium, including the capsule and tendons of the rectus femoris from the superior acetabular lip and the anterior inferior iliac spine.

- Once the pouch has been created, dislocate the femoral head into the pouch under the gluteus muscles and retract it with a sharp, narrow Hohmann retractor driven into the ilium superior to the acetabulum and resting on the femoral neck (Fig. 4-4E). Additional pins may be driven into the ilium and ischium to help with the acetabular exposure. A retractor also is placed inferiorly to expose the transverse acetabular ligament. Sharply excise the labrum.

- Ream the acetabulum medially through the cotyloid notch of the acetabulum to the medial wall. Take care not to ream through the medial wall. Once medialized, the reamers are used to increase the bony acetabulum to the desired size. The acetabulum usually is underreamed by 1 mm from the desired component size. Use...
**FIGURE 4-4** Hip resurfacing procedure. 

A, Skin incision for posterolateral approach to hip. 

B, Completed soft tissue dissection. 

C, Anterior capsule divided along course of psoas tendon sheath. 

D, Measurement of femoral neck diameter. 

E, Femur retracted well anteriorly to allow access to acetabulum. 

F, Cup trial used to determine correct implant positioning. 

*Continued*
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G, Osteophytes removed posteroinferiorly and anteroinferiorly. H and I, Cup positioning in abduction and anteversion using preoperative template (J) to determine correct valgus angle. K, Acetabular component fully impacted in 10 to 20 degrees anteversion and 35 to 45 degrees abduction. SEE TECHNIQUE 4-1.
an acetabular trial to assess the potential component’s stability. The trial components in the BHR system are 1 mm smaller than their stated size to provide for tighter fitting of the actual component. Impact the trial into the acetabulum with a mallet, and excise osteophytes for unobstructed cup insertion (Fig. 4-4F and G). If that size trial is tight, the acetabular implant of the same size is selected. If the trial is loose, the acetabulum may be reamed 1 or 2 mm more to the next size acetabular component that matches the appropriate size femoral head. There are two acetabular sizes per femoral head size available. The trial should be used for the larger cup size; if it is tight, that cup should be selected. Mark the edge of the trial with electrocautery inside the acetabulum to predict the depth of the implant when inserted.

- It is critical for the long-term success of the hip that the acetabular component’s orientation is done correctly. Implant the acetabular component in 10 to 20 degrees of anteversion and 35 to 45 degrees of abduction (Fig. 4-4H-J). If greater than 50 degrees of abduction is accepted or there is more than 25 degrees of anteversion, the metal femoral head component may be subjected to edge wear and associated with accelerated metal debris and ion production.

- To properly insert the acetabular cup, push the insertion tool down against the inferior portion of the wound (Fig. 4-4K). The mark made on the inside of the acetabular wall while the trial was in place is used to judge if the acetabular component is fully seated (there are no holes in the cup). Remove periacetabular osteophytes to the edge of the cup.

**DYSPLASIA CUP**

- The dysplasia cup is used when there is significant acetabular dysplasia or lateral or superior erosion of the rim of the acetabulum. It is only 3 mm larger than the femoral component and has two screw holes external to the rim of the cup for superior and posterior screw fixation (Fig. 4-5A). Cup preparation and position are the same. Drill the holes for the screws using a drill guide through the

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**FIGURE 4-5**

A, Dysplasia cup. B, Screw insertion. C, Distance from tip of trochanter to point on lateral cortex as seen while templating. Point marked with electrocautery to then align varus or valgus rod. **SEE TECHNIQUE 4-1.**

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RESURFACING OF FEMORAL HEAD

To resurface the femoral head, internally rotate the femur much farther than needed to perform a total hip replacement. With the soft tissue release, which was already discussed, this may be safely done, even though the position may seem extreme and more force than usual is required. Fear of femoral fracture should not be great, however, because resurfacings of the hip should be done only in patients with hard bone.

- Flex the femur to 80 to 90 degrees and then internally rotate it between 120 and 150 degrees to expose the femoral head and neck circumferentially. The anterior portion of the head is most difficult to expose. A retractor between the acetabular cup and the proximal femur lifting the femur out of the wound may be helpful.
- With the femoral head and neck exposed, remove periarticular osteophytes, taking care not to violate the bone of the femoral neck. A Kerrison rongeur may be helpful anteriorly. Take care not to strip soft tissue from the femoral neck that contains vessels supplying the femoral head.

- Place a guide pin down the center of the femoral head. There are two jigs designed to help with pin placement. The jig we have most experience with is a clamp design that has two legs that clamp around the femoral neck superolaterally and inferolaterally. Place a long guide rod posteriorly over the femoral neck to orient the jig in a valgus position (Fig. 4-6A). The lateral tip of that guide rod should line up with the point marked on the lateral femoral cortex and its soft tissue mark made after measuring down from the greater trochanter. This ensures the placement of the pin down the center of the femoral neck in proper valgus alignment. View the guide pin from the medial side of the neck to be certain that it is not placed in retroversion (Fig. 4-6B). The guide pin position should be completely evaluated by its orientation to the femoral neck and not the femoral head. The pin usually is placed superior to the fovea, but, with wear, the head may be deformed.

- Once the guide pin is inserted down the middle of the femoral neck in anterosuperior and lateral planes, use a cannulated reamer to ream over the pin. Remove the pin and place a large reaming guide rod into the hole in the head and neck. Take circumferential measurements with a feeler-gauge to be certain the selected head size will not notch the femoral neck, especially laterally and superiorly (Fig. 4-6C). Once this has been confirmed, ream the femoral head circumferentially with the correct size reamer (Fig. 4-6D and E). Protect the femoral neck from notching with the measurement tool.

- Measure to see how far above the head-neck junction line the head needs to be resected (Fig. 4-6F), and ream the head to that line (Fig. 4-6G and H). A chamfer reamer of the correct size is used to finalize the shape of the femoral head to match the geometry of the interior of the femoral head component (Fig. 4-6I). Remove the reaming rod.

- Drill small to medium cement fixation holes into the femoral neck around the chamfer and the tip of the head (Fig. 4-7A). Ream the hole in the femoral head and neck to a larger size with the appropriate head and neck reamer (Fig. 4-7B).

- Drill a hole into the lesser trochanter and place a metal vent in this hole to vent the proximal femur during cementing of the femoral component. This vent is attached to suction. A very viscous cement is mixed in a vacuum for a short time and then injected into the femoral component (Fig. 4-7C). While the cement is in a liquid state, cement the component down to the femoral head (Fig. 4-7D). Take care not to break the femoral neck while impacting the component down onto the head. Remove excess cement and the vent tube. Carefully reduce the hip to avoid scratching the metal head against the edge of the acetabular component.

- Close the capsule with a running absorbable suture. Repair the gluteus maximus and the piniforms. Drains are usually used, and the fascia is routinely closed.

POSTOPERATIVE CARE. Early mobilization is encouraged. Most patients are encouraged to walk the afternoon or evening of surgery. No abduction pillow is used because the femoral head is so large the risk of dislocation is small. Physical therapists are informed that the patient has a resurfaced hip and does not need hip precautions.
FIGURE 4-6


Continued
FIGURE 4-6, cont’d  G-I, Head is reamed to line after measuring how far femoral head needs to be reamed. J, Femoral head shaped to match geometry of femoral head component. SEE TECHNIQUE 4-1.
FIGURE 4-7  

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